JOINT ROUTING PROTOCOL AND IMAGE COMPRESSION ALGORITHM FOR PROLONGING NODE LIFETIME IN WIRELESS SENSOR NETWORK

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To my family and friends

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ABSTRACT

Wireless sensor network (WSN) are among the emerging modern technologies, with a vast range of application in different areas. However, the current WSNs technology faces a key challenge in terms of node lifetime and network connectivity due to limited power resource of the node. The conventional data routing protocols do not consider the power available at the node on the path from source to sink, thus they result in the exhaustion and eventual death of nodes surrounding the sink node, thus generating routing holes reducing the network throughput. In order to address the issue in this research presents a novel protocol based on equal power consumption at all network nodes. The consume power fairly (CPF) protocol achieves a high power efficiency by distributing power consumption equal on all the network nodes. The protocol compares the power available on all the paths from source to sink and then selects the path with highest power. Additionally in order to reduce the transmitted data size, a lossy image compression technique based on adaptive Haar wavelet transform has been implemented. The simulation designs based on MATLAB consists of 100 randomly distributed nodes over an area of 100 m^2, with 30 Kbits and 40 Kbits of packet sizes. The comparison between the proposed CPF protocol and the energy aware protocol has been carried out on the basis of number of iterations and the dead nodes in the network. Thorough simulations have been carried out based on different number of network iterations to validate the potential of the proposed solution. Moreover the implemenetation of multiscale retinex technique results in image enhancement and impoved classification. An implementation of the CPF protocol and image compression technique on a 100 node network with 500 iterations, results in the death of 13 nodes as compard to 38 dead nodes with energy aware protocol for the same network. Thus the performance comparision of CPF and energy aware protocol demonstrates an improvement of 81.19% for the energy consumption of the network. Thus the proposed algorithm prolongs the network under consideration by 57 – 62% as compared to networks with conventional routing protocols.

ABSTRAK

Rangkaian sensor tanpa wayar (WSN) adalah antara teknologi moden yang baru muncul, dengan julat aplikasi yang luas mencakupi berbagai bidang. Walaubagaimanapun, teknologi WSN semasa menghadapi cabaran utama dari segi jangka hayat nod dan sambungan rangkaian disebabkan sumber kuasa terhad bagi sesuatu nod. Protokol penghalaan data lazim tidak mengambil kira kuasa yang berada di dalam nod di atas laluan dari punca ke sink, oleh itu ia menyebabkan kehilangan kuasa dan akhirnya berlaku nod mati di sekeliling nod sink, yang mana akhirnya menghasilkan lubang penghalaan dan mengurangkan hasil pemprosesan rangkaian. Untuk menangani masalah dalam penyelidikan ini, suatu protokol yang baharu berasaskan penggunaan kuasa yang seimbang bagi semua nod rangkaian. Protokol penggunaan kuasa secara adil (CPF) menghasilkan kecekapan kuasa yang tinggi dengan mengagihkan penggunaan kuasa yang sama pada semua nod rangkaian. Protokol ini membandingkan kuasa yang terdapat pada semua laluan dari sumber ke sink dan kemudian memilih laluan yang mempunyai kuasa tertinggi. Tambahan lagi, bagi mengurangkan saiz data yang dihantar teknik pemampatan imej berasaskan transformasi wavelet Haar adaptif diperkenalkan. Rekabentuk penyelakuan adalah berdasarkan kepada perisian MATLAB mengandungi 100 nod teragih secara rawak dalam kawasan 100 m^2, dengan saiz paket 30 kbit dan 40 kbit. Perbandingan di antara protokol CPF yang dicadangkan dan protokol berasaskan tenaga yang berada di pasaran, telah dilaksanakan dengan kadar iterasi dan bilangan nod yang mati dalam rangkaian. Penyelakuan menyeluruh yang dilakukan adalah berdasarkan bilangan iterasi untuk memastikan penyelesaian yang dicadangkan adalah tepat. Pelaksanaan menggunakan teknik pelbagai skala retineks menghasilkan imej yang baik dan meningkatkan keupayaan pengkelasan. Pelaksanan protokol CPF dan teknik mampatan imej ke atas 100 node dan 500 iterasi, membawa kematian nod hanya 13 berbanding dengan 38 nod mati menggunakan protokol sedar tenaga. Oleh itu perbandingan prestasi bagi protokol sedar tenaga dan CPF bersama dengan pemampatan imej menunjukkan peningkatan sebanyak 81.19 penggunaan tenaga yang

lebih efisien. Oleh itu algoritma yang dicadangkan memanjangkan hayat rangkaian yang dipertimbangkan kepada 57 - 62% berbanding dengan rangkaian dengan protokol penghalaan lazim.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ACK	-	Acknowledgment
ACT	-	Adaptive Compression – Based Congestion Control Technique
ADPCM	-	Adaptive Differential Pulse Code Modulation
AODV	-	Ad-hoc On Demand Distance Vector Routing
AVG	-	Average Queue
BS	-	Base Station
CCA	-	Clear Channel Assessment
CCN	-	Completely Connected Network
CH	-	Cluster Head
CM	-	Cluster Member
CPF	-	Consume Power Fairly protocol
CS	-	Compressive Sensing
CSMA/CA	-	Carrier – Sense Multiple Access with Collision Avoidance
CWT	-	Continuous Wavelet Transform
DAIPas	-	Dynamic Alternative Path Selection Scheme
DD, DI	-	Direct Diffusion
DPCM	-	Differential Pulse Code Modulation
DSTD	-	Distributed Structure Tree Depression Algorithm
DWT	-	Discrete Wavelet Transform
EAP	-	Energy Aware Protocol
GPS	-	Global Position System
H	-	Hop
HAAR	-	Alferid Haar Algorith
HSV	-	Hue, Saturation, Value
HWT	-	Haar Wavelet Transform
IBSS	-	Independent Basic Service Set
IP	-	Internet Protocol
LEACH	-	Low Energy Adaptive Clustering Hierarchy

LVQ	-	Learning Vector Quantization
MAC	-	Medium Access Control
MANET	-	Mobile Ad-Hoc Network
MAXth	-	Maximum Threshold
MSE	-	Mean Square Error
MSR	-	Multi Scale Retinex
N	-	Node
P	-	Path
PAN	-	Personal Area Network
PSNR	-	Peak – Signal Noise Ratio
RSS	-	Received Signal Strength
TARA	-	a Topology Aware Resource Adaptation
TMT	-	Triangular Matrix Table
WANET	-	Wireless Ad-Hoc Network
WSN	-	Wireless Sensor Network

LIST OF SYMBOLS

d	-	distance
E	-	energy
f	-	link
H	-	hops
i,j	-	the link index from node i to node j
k	-	k-bit
T	-	hops
P	-	number of possible path
RP	-	residual power
TP	-	total power
PN	-	power needed
RT	-	routing table
E_R	-	energy receive
E_T	-	energy send
m	-	incremental cost
L	-	payload
b	-	fixed cost
U	-	used energy for each node
U_i	-	average used energy
N	-	total number of node in the network
n	-	number of bytes for data payload
σ	-	average of energy
pJ	-	*peak joule*
H	-	houre
J	-	joule

m	-	meter
m^2	-	*meter square*
sec	-	second
W_N	-	first level Haar wavelet
V_N	-	first level scaling signal
X	-	gray level of input image
$P(x)$	-	histogram of input image
L	-	total number of the gray level

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

This chapter will discuss about the overview on wireless sensor network (WSN). The objectives according to the problem statement is also highlighted. The significant features of this research in the form of contribution are also provided.

1.1 Research background

Wireless sensor network (WSN) are a type of sensors spatially distributed to monitor physical or environmental conditions, such as pressure, temperature, sound, vibration, motion, pulse, machine health monitoring, environment, habitat monitoring, health care applications, home automation, and traffic control. WSNs have been used in versatile applications in many different fields such as civilian domains, building and industrial complexes. In industrial complexes it includes monitoring, process, and control. WSNs have no infrastructure except the sink node and few other controller nodes. It is categorized as infrastructure less network as compared to cellular network. Every node can communicate to an unknown number of nodes. Each sensor node manages a variety of network services such as data compression, coverage, localization, synchronization, and security. This breakdown of management is for the purpose of enhancing the network's overall performance. Typical WSN may consists of five-layer communication protocol stacks. They are physical layer, data link layer, network layer, transport layer, and application layer, in order. The most important concern in WSN is the need for low power operation because it is tiny and operates autonomously. These nodes collect data from their environment. They then cooperate to forward data to sink node. Due to their diversity, WSNs have massive probability for large number of applications with its own unique requirements and characteristics.

From this perspective, researchers develop different algorithms that are suitable for many different applications and scenarios. In WSN implementation, the specific issues that are taken into consideration by designers are data aggregation, data reliability, localization, node clustering, energy aware routing, events scheduling, fault detection and security.

Wireless sensor network had been widely used in the different fields such as military, health care monitoring, environmental and earth sensing, Industrial monitoring and control. WSN systems are perfect for an application in environmental evaluation wherein the specifications mandate a long-term distributed monitoring and control solutions to manage soil, water or climatic variations. Also, all sensor nodes must be able to decrease energy consumption and manage the resources efficiently.

Figure 1.1: Number of Sensors [3]

In Figure 1.1 shows the huge number of sensors in the world. That’s means in the future definitely the number will increase exponentially. Therefore, the world will face challenging issues in wireless communication techniques especially energy efficiency. The application of WSNs in industry brings huge benefits such as increasing remote sensing, without costing wires, besides this the benefits include energy and labour saving along with productivity increase. Additionally, the power cast technology can support many applications such as sensing temperature, humidity, management of industry, monitoring of industry and instrument health. The Figure 1.2 shows most application for WSN [3].

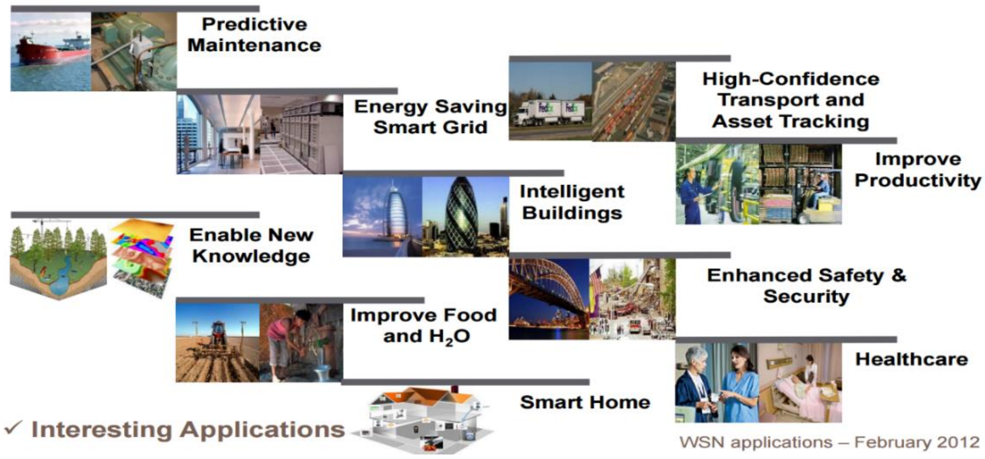

Figure 1.2: WSN Application [3]

WSN mostly use two famous protocols for network connectivity and transmissions namely ZigBee and IEEE 802.15.4. Both the protocols the max coverage range is between 50 – 100 m. Both the protocols were introduced to support low data rate applications. However, Both the technologies got merged later with the name of ZigBee. ZigBee is a low cost and low power connectivity solution with also power efficient solution for low power applications. Due to its diversity of applications this research also uses ZigBee protocol for data transmission and network connectivity between nodes.

WSN [1] is the subnet of wireless ad-hoc networks [2]. In WSN the most essential communication element is routing, since the backbone of a network is in charge of forwarding packets among nodes. The routing protocol layer plays an essential role in improving the performance of wireless networks for fixed and mobile nodes in the network. Forwarding of large amounts of data from one node to another may results in shorter network lifetime. In this case it may lead to possibility of death to the network. Therefore, it is desirable to design a routing protocol for WSN with the ability of achieving high power efficiency by distributing power consumption equally on all nodes in the network. This research ultimately considers a complete methodology for the energy consumption problem in sensor networks, and routing algorithm to support energy saving in the network. The traditional method is done by measuring selectively a low-power microcontroller or transceiver not sufficient to achieve energy saving over the entire network. Therefore, study and focus on the design objectives looking into different aspects of application such as network configuration code, code, routing algorithms, data compression, and wireless devices to come up with an energy efficient network.

This research addresses the problem of unequal energy consumption in WSN that effects the network lifetine and throughput. A network routing protocol based on fair consumption of energy among the nodes have been introduced in order to prolong the network life time. It presents the simulated models for a 100 node network, distributed randome in an area of 100 m^2. A comparison has been drawn between the proposed and the energy aware protocol based on the number of dead nodes in the network after a designated number of iterations. In order to reduce the size of the transmitted data, data compression technique based on lossy compression has been implemented. In the end a combination of CPF protocol and data compression has been implemented and investigated thoroughly with different number of iterations to monitor the performance of a prolonged network connectivity.

1.2 Statement of problem

WSNs are usually deployed in rough physical environments with a limited battery power. The network may consist of hundreds or thousands of nodes with large physical distributions, making recharging almost impossible. Thus energy saving is always a key concern in such limited power systems. This problem has motivated the nodes, network and system designers to upgrade the traditional WSNs to reduce energy consumptions. In response, the IEEE 802.15.4 standard was introduced, however, it was developed to handle low data rate applications and needed longer durations for transmission to reduce power consumption.

Additionally in WSNs the communication of a far end node to the sink is made possible by intermediate nodes. Thus continuous routing of data packets from the node to sink via intermediate nodes exhausts the intermediate nodes and increases the power consumption at the intermediate nodes. Thus resulting in the death of intermediate nodes and creating of holes in the network. The intermediate nodes near the sink are the first ones to die due to highest power consumption. Thus, eventually with no load balancing, the WSN network collapses.

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